Technical Memorandum 4-76

WEAPON PERFORMANCE TESTING AND ANALYSIS: THE MODI-PAC ROUND, THE NO. 4 LEAD-SHOT ROUND, AND THE FLYING BATON

Brenda K. Thein
Donald O. Egner
Ellsworth B. Shank

January 1976

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The primary purpose of this report is the presentation of performance data for the three items tested; namely, the MODI-PAC, the No. 4 lead-shot round, and an experimental item, the Flying Baton. These items were tested as a first step in determining their potential as less-lethal weapons.

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APPROVED: John D. Weisz
JOHN D. WEISZ
Director
U. S. Army Human Engineering Laboratory

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland 21005

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Director

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Joseph T. Kochanski
Director

Less Lethal Weapons Evaluation Program
Lester D. Shubin
Manager

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TABLES

EXECUTIVE SUMMARY

Little testing of either ammunition, the weapon, or the man-weapon system has been performed utilizing commercially available kinetic-energy-type less-lethal weapons. This task has been concerned with such testing of a limited number of these items.

The items tested were the MODI-PAC, a proprietary item of Remington Arms Company, a standard 12-gauge round of No. 4 lead shot, and an experimental round, the Flying Baton. The later round was originally conceived as an unstable rod. However, in order to permit the rod to be launched from the test barrel, it was necessary to utilize end-plugs giving it the appearance of a baton. Thus, the name "Flying Baton" was coined.

Measurements were made of the horizontal and vertical dispersions for the two shotgun-launched rounds. Additionally, accuracy measures were taken of the center-of-impact for these rounds. For the Flying Baton round, flight and impact orientation measures were taken, as well as accuracy measures.

Comparisons were made between the MODI-PAC and the No. 4 lead-shot round with regard to their physical performance. The Flying-Baton round was roughly compared to the standard .38-caliber round previously tested by this research group. It was recommended that all three items be considered for further examination, i.e., scenario application and/or physiological testing.

WEAPON PERFORMANCE TESTING AND ANALYSIS: THE MODI-PAC ROUND, THE NO. 4 LEAD-SHOT ROUND, AND THE FLYING BATON

INTRODUCTION

People are killed, sometimes unavoidably in the course of police work. Police and public agencies are, therefore, paying special attention to the role played by the choice of weapons available to law enforcement agencies. There is a great deal of concern for providing a police officer with the capability to apply a moderate level of force in those situations where the use of his present police revolver would be too extreme (or would present a hazard to innocent bystanders). In fact, basic to this philosophy, a conference on Research Needs for Law Enforcement co-sponsored by the Justice Department and the National Science Foundation was held in November 1971 in Washington, DC. It was the judgment of this conference that less-lethal weapons offered a solution to the problem of effective alternatives to lethal weapons in the hands of law officers.

At that time, the Military and Civilian Law Enforcement Technology Team of the US. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, was tasked by the Law Enforcement Assistance Administration with the responsibility for providing a methodology or technique for evaluating these less-lethal weapons.

The kinetic-energy phase of the complete evaluation technique can be found in a draft report entitled "A Multidisciplinary Technique for the Evaluation of Less Lethal Weapons", Volume 1.[1] In general, the methodology developed in the aforementioned report includes the use of standard scenarios, weapon performance data, and a determination of physiological and "nonphysiological" effects from both the desirable and the undesirable effectiveness standpoint.

To date, the evaluation technique has been applied to two commerically available kinetic-energy-type weapon systems, viz., the standard .38 caliber police ammunition and the Stun-Bag.[2] The first selection, the .38 caliber was chosen not because it was a less-lethal weapon per se, but because it was a familiar police weapon and would provide a good baseline against which the so-called less-lethal weapons could be compared. Evaluation of the .38 caliber can be found in the draft report "A Multidisciplinary Technique for the Evaluation of Less Lethal Weapons Volume II: Effectiveness and Safety Characteristics of the .38 Caliber Weapon System".[3] The Stun-Bag, on the other hand, was selected for evaluation both because of its popularity and because it was representative of a class of less-lethal weapons (and also because it would serve as a further test of the methodology itself). Evaluation of the Stun-Bag can be found in a draft report entitled "Analysis of a Bean-Bag-Type Projectile As A Less Lethal Weapon".[4]

It was the purpose of the present task to discover which other kinetic-energy-type less-lethal weapons/ammunition were commercially available and to determine through the testing of the available items those that showed promise (in terms of physical performance) and that should,

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[1] Available from The Law Enforcement Assistance Administration, Department of Justice, Washington, DC. 20530

[2] Proprietary item of MB Associates, San Ramon, California

[3] Also available from The Law Enforcement Assistance Administration

[4] Also available from The Law Enforcement Assistance Administration

therefore, be considered for further evaluation (such as physiological testing and scenario application).

APPROACH

When this present task was initiated, the following assumptions were made:

a. There were several commercially available kinetic-energy-type less-lethal weapons/ammunition available.

b. In the area of commercially available less-lethal weapons/ammunition there has been little testing of either the ammunition, the weapons, or the man/weapon system.

In order to corroborate the first assumption, an extensive search was conducted for the dual purpose of (1) identifying available items and (2) determining those items presently owned by, or of interest to, the various law enforcement agencies. This search included interviews with several police departments, coordination with the International Association of Chiefs of Police (IACP), and a review of current open-literature, such as newspapers, magazines, and manufacturers' literature.

Although a considerable amount of time and effort was expended in support of this first assumption, the results obtained were almost nil. Virtually none of the police departments that were contacted claimed ownership of any kinetic-energy-type less-lethal weapons/ammunition, nor did they indicate any interest in the evaluation or ownership of any particular item(s). Attendance at the IACP convention netted one item for possible evaluation, viz., the MODI-PAC, manufactured by Remington. A review of the open literature revealed that a few police departments had purchased some Stun-Guns/Stun-Bags (previously evaluated) and also that some prisons were interested in the MODI-PAC for use in controlling disturbances.

Since the net result for testing, thus far, was one item, viz., the MODI-PAC, the decision was made to select two additional items that had previously been of interest. These additional selections were the Ricochet Round by First Round, Inc., and the TASER by TASER, Inc. (The TASER was selected for this task strictly for the purpose of obtaining accuracy measurements and not for measuring the electrical charge it dispensed.) However, numerous attempts to purchase the Ricochet Round met with failure. Additionally, preliminary contact with TASER, Inc. yielded constraints for testing the TASER so that it was decided to refrain from testing this item.

Therefore, the final selection of items for testing were (1) the MODI-PAC, (2) a standard 12-gauge shotgun round of No. 4 lead shot (to provide a comparison baseline for the MODI-PAC), and (3) an experimental round, the "Flying Baton".

The information obtained from testing the above items includes a physical description of each item, accuracy data (for the MODI-PAC and lead-shot rounds this is an approximate value obtained by estimating the center of impact with respect to the aim point), and estimating dispersion (for the MODI-PAC and lead-shot rounds). Additionally, test results for the MODI-PAC and lead-shot rounds include basic information on the ammunition/weapon and the man/weapon system.

MODI-PAC

The first item evaluated was the MODI-PAC[5]. The MODI-PAC which stands for "modified impact" is a 12-gauge shotgun shell loaded with approximately 320 lightweight, polyethylene pellets weighing about one-quarter ounce. It has a white translucent shell body, a roll crimp with a red/top wad and a copper-plated head to provide distinctive "instant identity" aids. It was developed by Remington Arms Company to give law-enforcement people a weapon that has a limited range and reduced on-target or "deterrent impact" effects. Remington, in its literature, estimates the effective tactical range to be from 3 to 15 yards. Remington also states that at 20-25 yards the pellets will not penetrate a single sheet of newspaper, while at ranges decreasing from 3 yards the impact energy increases sharply; in fact, at 1 yard the impact energy is estimated to be equivalent to that of a 210 grain, .41 magnum caliber lead bullet (approximately 1,050 foot pound).

Testing was conducted at an outdoor range during November 1974. Rounds were fired for two test configuration for several ranges of interest (1, 3, 5, 10 and 12 yards). The first test configuration involved firing directly at the target while the second test configuration involved the use of a ricochet or bounce-firing technique. (This second test configuration was the one recommended by Remington for actual-use situations.)

The weapon utilized in the testing of the MODI-PAC (and the No. 4 lead-shot round) was a High Standard 12-gauge riot gun with a 20-inch barrel. All gunners were experienced shooters.

The target consisted of a sheet of plywood covered with an 8' x 8' sheet of celotex which in turn was covered with brown target paper. A silhouette approximating a "standard" 5' 10" man was drawn on the target paper. For firing using the direct-fire method the "X" or aim point was placed at about "belt-buckle height", i.e., approximately 40 inches from the ground. The reason for choosing this aim point rather than the conventional center of mass (center of the chest) aim point was because of the nature of the ammunition being tested. That is, since the pellet pattern was spread, it was unwise to place the aim point too high; thereby increasing the probability of one or more of the pellets impacting in the orbital (eye) area (this could result in severe eye damage, an obviously undesirable effect). On the other hand, it was considered desirable to determine, at least roughly, how high the aim point could be set utilizing the direct-fire method and still have a very low probability of impacting the orbital area.

Table 1 and Figure 1 below give the pattern of average dispersion (extreme spread) for the MODI-PAC for the direct-fire mode for all shooters for the ranges of interest. It can be seen from the aforementioned table and figure that pellet distribution is fairly symmetrical.

In addition, Table 2 below, gives the average dispersion for the direct-fire mode for each individual shooter for the ranges of interest. As is evident, the variation between shooters was negligible and, therefore, had essentially no effect on the group results.

The accuracy data for the MODI-PAC was obtained by measuring the horizontal and vertical coordinates of the center-of-impact with respect to the aim point for each shot fired. As mentioned previously, for this test series the numbers obtained were approximate values (based

[5]Proprietary item of Remington Arms Company, Bridgeport, Connecticut

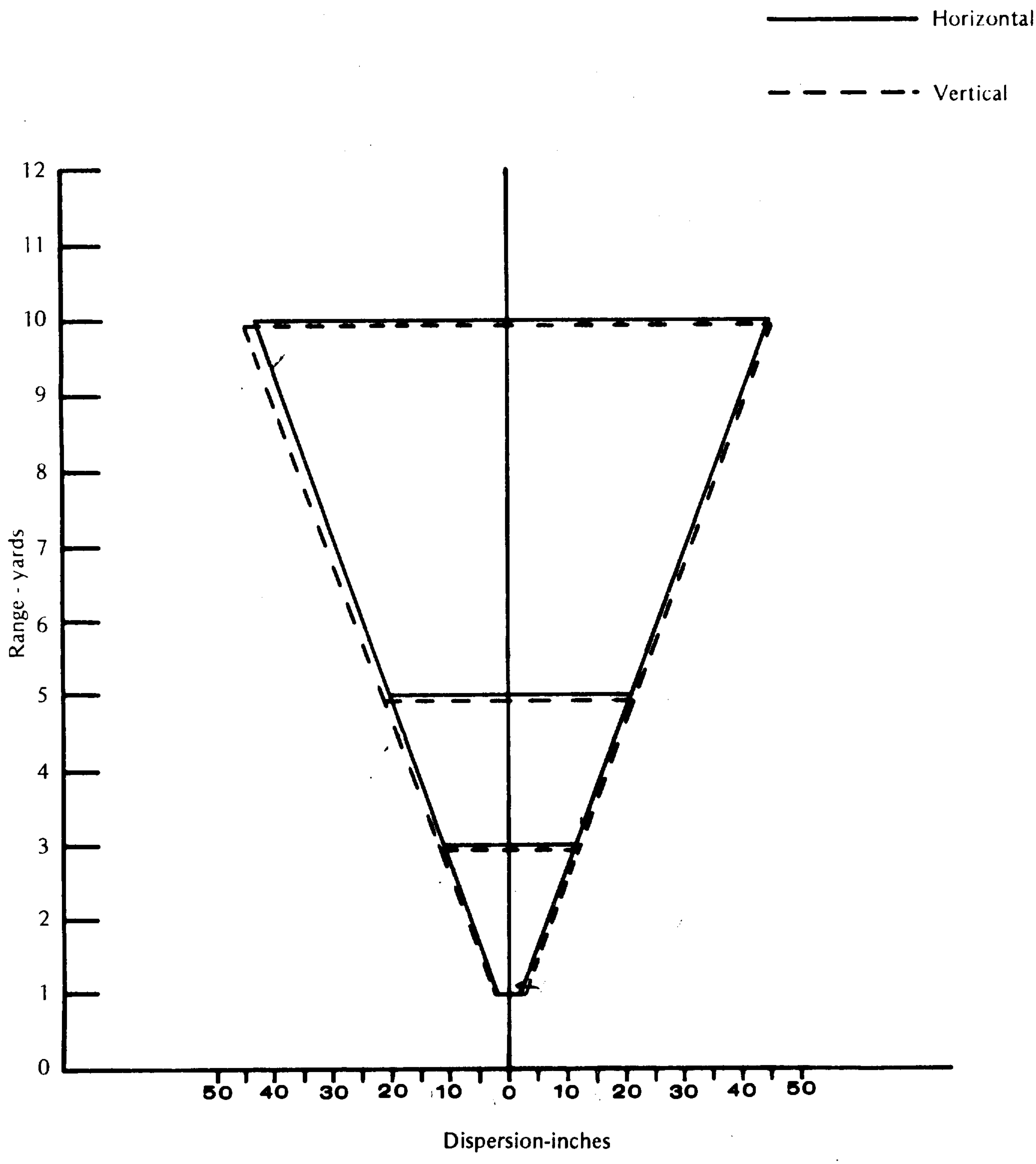


Fig. 1. MODIPAC direct fire—all shooters.

TABLE 2

Average Pattern As A Function Of Range -
"MODI-PAC" - Direct Fire - Individual Shooters

Shooter Number	Range Yards	Horizontal Dispersion Inches	Vertical Dispersion Inches
1	1	4.1	4.0
2		4.3	4.3
3		3.9	3.9
1	3	20.4	20.7
2		22.5	21.1
3		23.5	21.7
1	5	44.3	43.2
2		39.4	40.6
3		41.3	43.9
1	10	90.2	91.5
2		89.3	90.0
3		83.1	84.1
1	12[a]	84.5	74.0
2		86.4	82.4
3		75.6	69.3

[a]It is felt that the dispersion measurements at this range are not completely reliable and that the actual dispersion was probably greater than the target frame area. (Approximately 67 pellets or only 21% of total available pellets impacted the target at this range.)

on a consensus of three people) and should be viewed as such, rather than being considered as "hard" numbers. With the aforementioned cautionings in mind, accuracy data for the MODI-PAC (for all shooters) is presented in Table 3.

For the second test configuration, a ricochet or bounce-firing technique was used. The technique involved aiming the weapon at a point on a steel floor approximately one yard in front of the silhouette target. (This was the distance recommended by Remington.) To bounce or skip the shot, the pellets must have a low angle of deflection (Figure 2)—behaving in a manner similar to a flat rock skimming off the surface of a body of water. The ricochet behavior of the shot pattern has a dual significance in crowd control. First, as a means of primary delivery, the vertical dimensions of the shot pattern can be more tightly constricted. Secondly, the ricochet behavior of the pellets results in generally reducing the height of pellets hitting behind a mob's front rank and striking persons in succeeding ranks after deflection off "ground" surface. Thus, damaging "high bouncing" pellets are virtually eliminated. (It should be noted here that a great deal of practice would be required in order to perfect the ricochet-fire technique. Although the shooters were experienced gunners, they were not experienced in the ricochet-firing technique.)

When the "MODI-PAC" is fired using the ricochet mode, the horizontal dispersion is from 1.4 to 2.0 times greater than the vertical dispersion, depending on the range of interest. The variations in dispersion can be seen in Table 4 below, as well as in Figure 3.

When comparing the results obtained using the direct-fire technique with those obtained using the ricochet-fire technique, it is observed that the measure of horizontal dispersion remains essentially the same (Figure 4); however, when considering the vertical dispersion, the direct-fire mode produces a dispersion that is nearly twice that obtained by employing the ricochet-fire mode (Figure 5). The smaller vertical dispersion factor is very important when the objective is to be effective without causing severe damage (e.g., pellets impacting in orbital (eye) area could cause severe damage at the closer ranges).

LEAD-SHOT

The second item tested was the standard 12-gauge shotgun round containing one ounce of No. 4 lead shot. The ammunition used was manufactured by Winchester-Western and is listed in their catalogue as the "Brush Load". As mentioned previously, the lead-shot round was tested utilizing the same test configurations that were used for evaluating the MODI-PAC's performance.

When the direct-fire technique is utilized for the lead shot, the horizontal and vertical dispersion patterns are also fairly symmetrical, as is evidenced in Table 5 and Figure 6.

Additionally, Table 6 gives the average dispersion utilizing the direct-fire method for each shooter for the ranges of interest. As with the MODI-PAC, in general, the overall variation among the shooters was so small that it produced no real effect on the group results.

Accuracy data for the lead-shot rounds was similarly obtained by measuring the horizontal and vertical coordinates of the center-of-impact with respect to the aim point for each shot fired. (Again, these are approximate values and should be considered as such.) The lead-shot accuracy data is presented in Table 7.

When the lead-shot rounds are fired using the ricochet or bounce-fire technique previously described, the horizontal dispersion is from approximately 1.6 to 2.6 times as great as the vertical

TABLE 3

Accuracy Data For The MODI-PAC - Direct Fire Mode

No. of Shooters	No. of Rounds	Range (yds)	μ_h (in)	σ_h (mils[a])	μ_v (in)	σ_v (mils[a])	σ_t (mils[a])
3	12	1	0	0	0.21	18.21	12.88
3	12	3	-0.13	2.09	0.29	3.67	2.99
3	12	5	0.17	3.21	0.08	5.00	4.20
3	12	10	0.60	14.84	1.44	16.07	15.47
3	12	12	-4.50	15.09	6.78	15.70	15.40

NOTE: h = horizontal
v = vertical
t = target
μ = mean miss distance
σ = standard deviation of miss distances

[a]At a range of one yard, one mil is 0.04 inches; at a range of 12 yards, one mil is 0.43 inches.

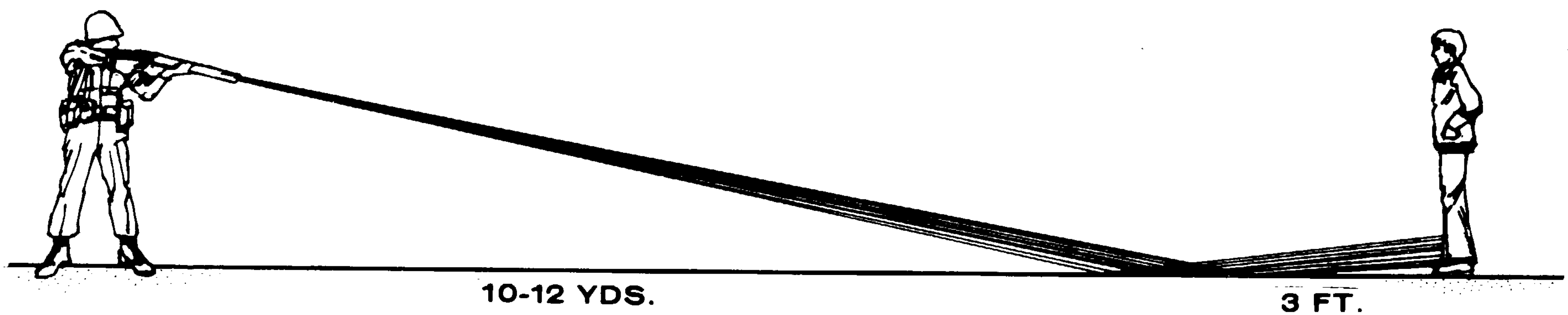


Fig. 2. Ricochet firing technique.

TABLE 4

Average Pattern As A Function Of Range -
"MODI-PAC" - Ricochet Fire - All Shooters

Range Yards[a]	Horizontal Dispersion Inches	Vertical Dispersion Inches
5	42.0	21.0
10	86.5	48.7
12	92.0[b]	68.0

[a]For range safety reasons, the one and three yard ranges were not used for the ricochet test-firings.

[b]Actual horizontal dispersion for this range was probably greater than target frame area.

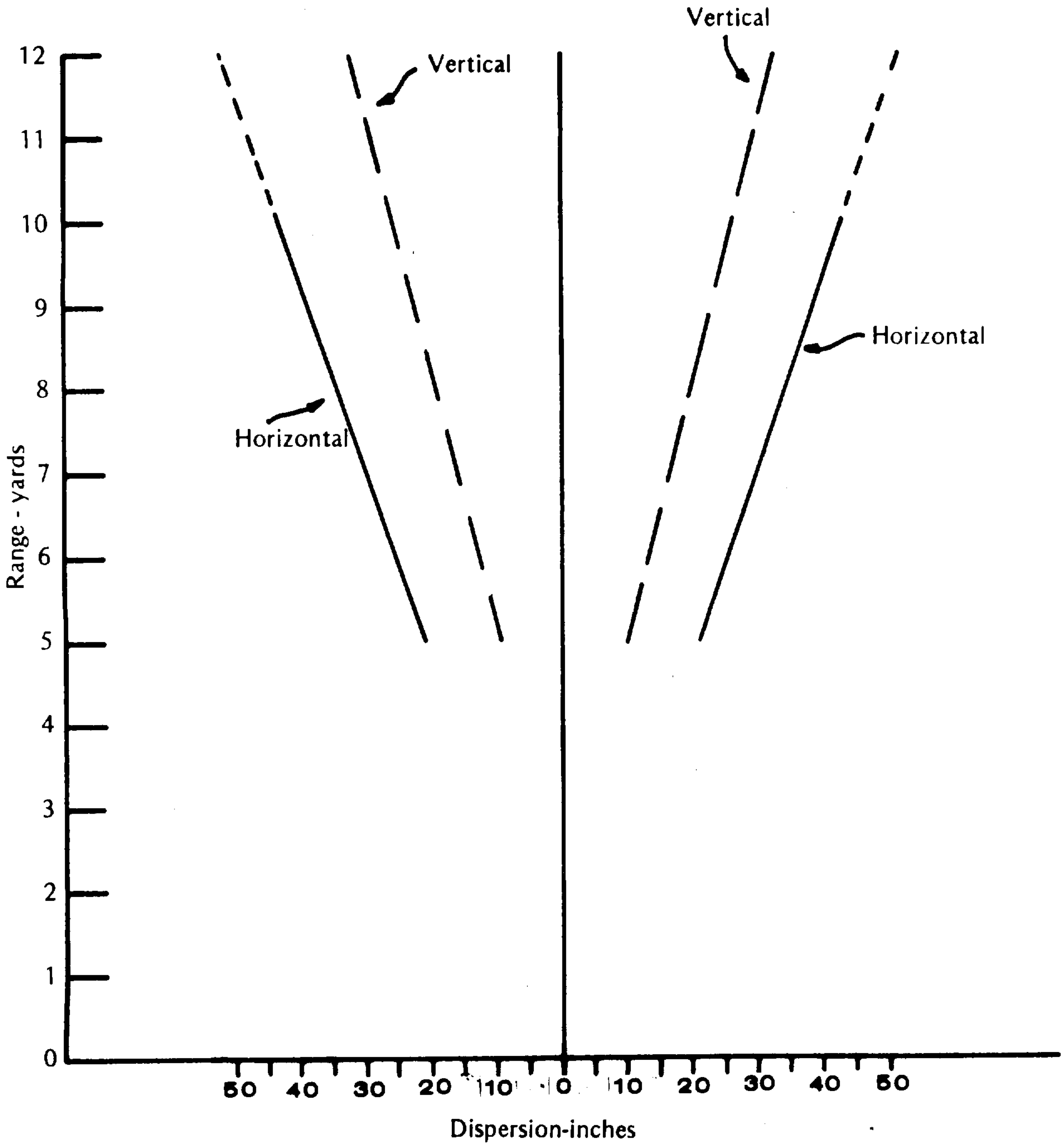


Fig. 3. MODIPAC ricochet fire—all shooters.

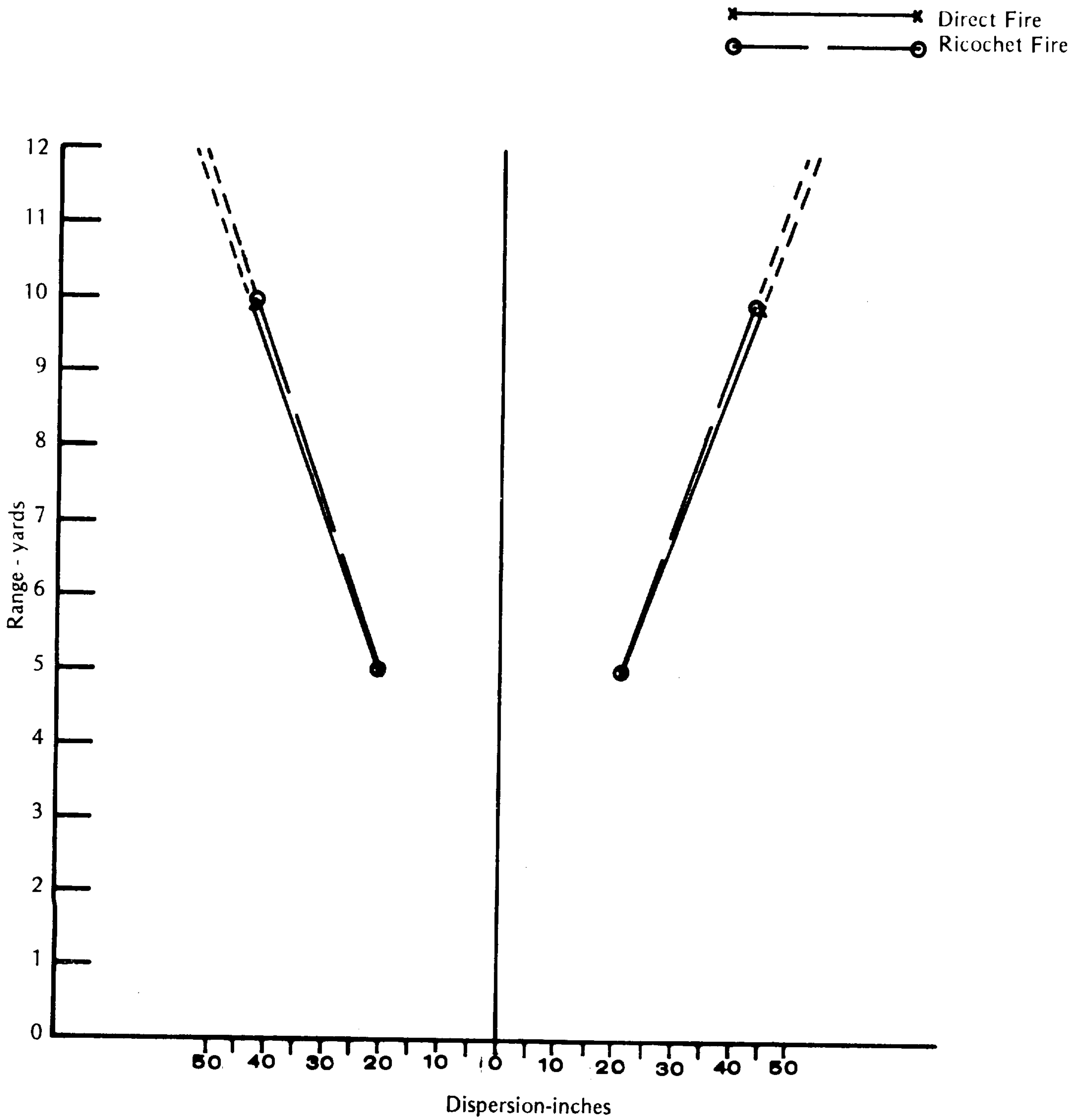


Fig. 4. Comparison of horizontal dispersion-MODIPAC—direct fire versus ricochet fire.

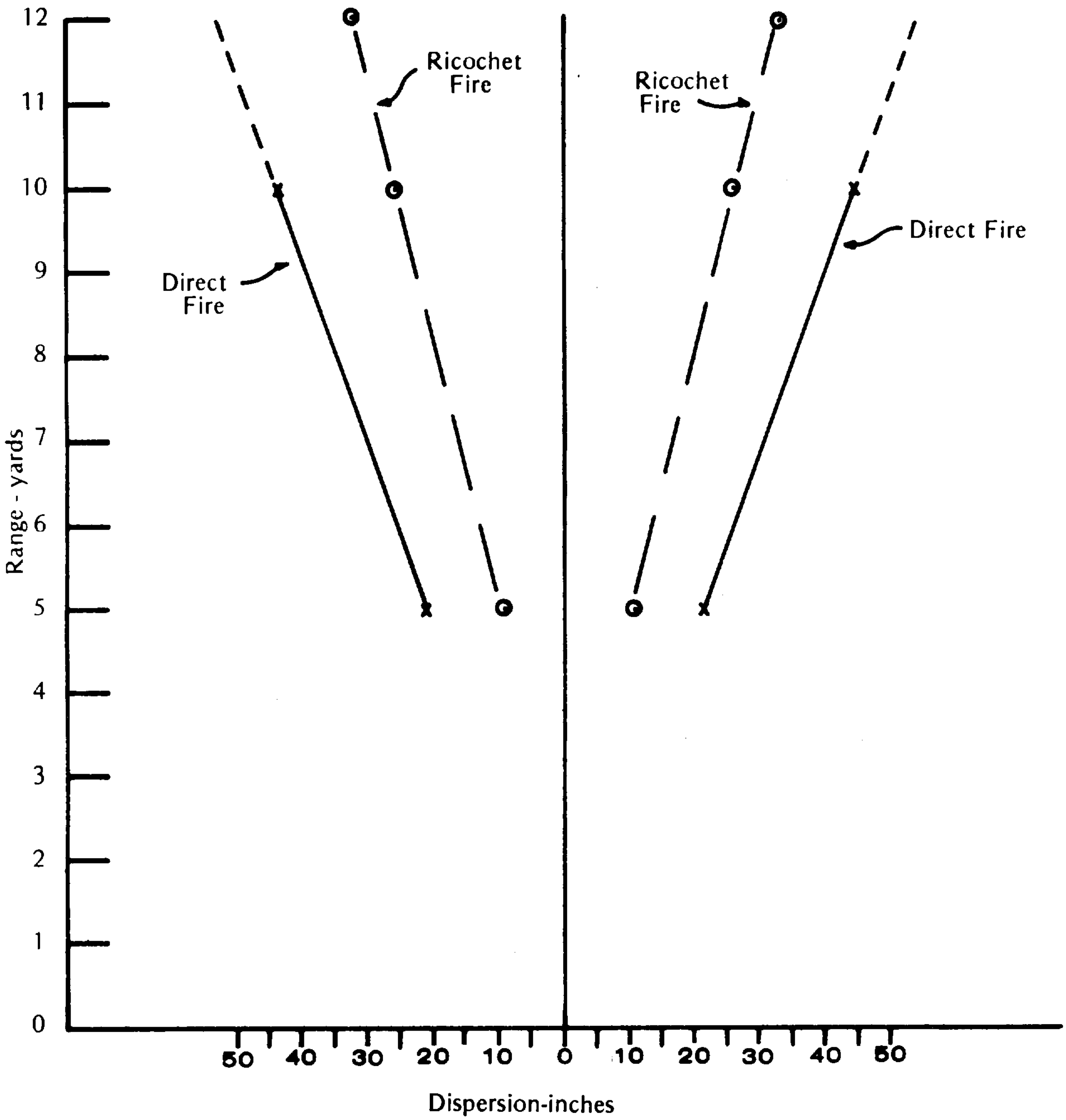


Fig. 5. Comparison of vertical dispersion-MODIPAC—direct fire versus ricochet fire.

TABLE 5

Average Pattern As A Function of Range -
No. 4 Lead Shot - Direct Fire - All Shooters

Range Yards	Horizontal Dispersion Inches	Vertical Dispersion Inches
1[a]	-	-
3	4.2	4.0
5	7.3	7.5
10	16.1	16.0
12	20.0	20.3

[a]In the interest of safety, there was no direct-fire shooting of lead shot at this range.

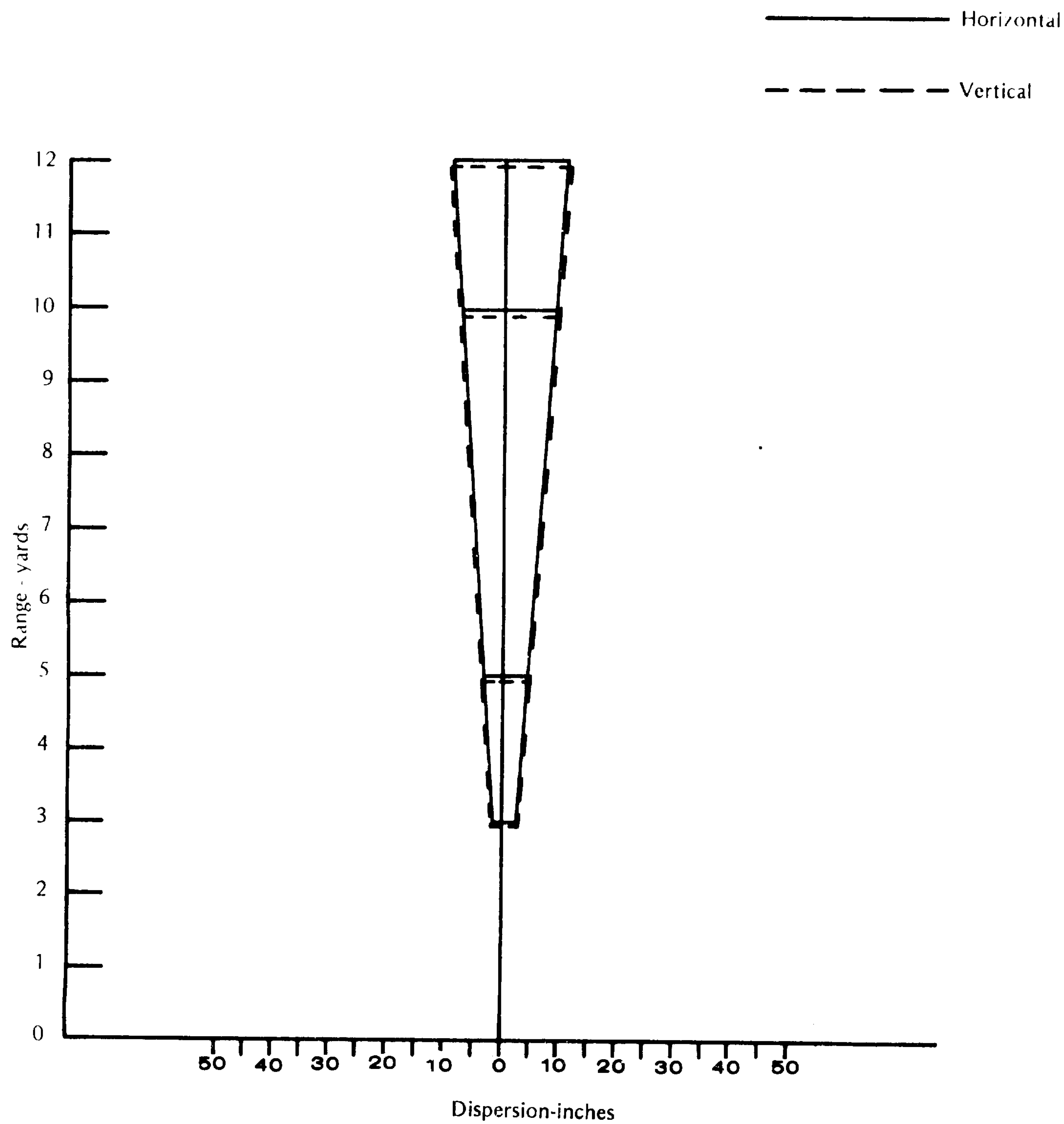


Fig. 6. No. 4 lead shot-direct fire—all shooters.

TABLE 6

Average Pattern As A Function Of Range -
No. 4 Lead Shot - Direct Fire - Individual Shooters

Shooter Number	Range Yards	Average Horizontal Dispersion Inches	Average Vertical Dispersion Inches
1	1[a]	-	-
2		-	-
3		-	-
1	3	3.9	4.1
2		4.6	3.9
3		4.2	3.9
1	5	7.5	7.8
2		7.6	8.1
3		6.9	6.6
1	10	16.7	15.7
2		16.5	16.3
3		15.2	16.0
1	12	20.6	20.0
2		20.3	20.3
3		19.2	20.5

[a]As noted for Table 5, no lead-shot rounds were fired at this range.

TABLE 7

Accuracy Data For No. 4 Lead Shot - Direct Fire Mode

No. of Shooters	No. of Rounds	Range (yds)	μ_h (in)	σ_h (mils[a])	μ_v (in)	σ_h (mils[a])	σ_t (mils[a])
3	9	3	-0.28	3.36	0.42	4.91	4.21
3	9	5	-0.06	2.93	0.69	6.58	5.09
3	9	10	-0.75	3.54	1.56	2.86	3.22
3	12	12	-1.15	4.89	3.11	3.79	4.37

NOTE: h = horizontal
v = vertical
t = target
μ = mean miss distance
σ = standard deviation of miss distances

[a]At a range of one yard, one mil is 0.04 inches; at a range of 12 yards, one mil is 0.43 inches.

dispersion, depending on the ranges of interest. Comparison of the horizontal and vertical dispersions can be found in Table 8, as well as in Figure 7.

Comparison of direct-fire and ricochet-fire techniques for the lead-shot rounds shows that the measure of horizontal dispersion remain essentially the same (Figure 8); however, comparison of the vertical dispersions for the lead-shot rounds for the aforementioned firing techniques shows that the direct-fire mode produces an average dispersion that is nearly twice that produced by employing the ricochet-fire mode (Figure 9).

Utilizing the general performance data for the lead shot as a baseline against which to compare the MODI-PAC, it is readily apparent that their performance characteristics are very similar. That is, for each test item (MODI-PAC and lead shot) when the direct-fire method was used, the horizontal dispersion was essentially equal to the vertical dispersion, and when the ricochet-fire method was used the horizontal dispersion was much greater than the vertical dispersion. However, when comparing the actual horizontal and vertical dispersions of the MODI-PAC with that of the lead shot utilizing both firing techniques, it is immediately apparent that the dispersions produced by the MODI-PAC are much greater; in fact an average of 5.5 times greater than the lead shot (Figures 10-13).

Additionally, when comparing the accuracy of the MODI-PAC with that of the No. 4 lead shot as in Table 9, it can be seen that the MODI-PAC was slightly more accurate at the very close ranges (3 to 5 feet) while at the longer test ranges the lead shot was much more accurate. However, the decrease in accuracy for the MODI-PAC at the longer ranges is to be expected since the round was designed for close-range confrontations. Since most police confrontations reportedly occur at ranges of 7 yards or less the MODI-PAC's decrease in accuracy at the longer ranges should not prevent this round from being selected for employment.

THE FLYING BATON

The investigation into techniques for the evaluation of less-lethal weapons took an unusual turn when, under this Weapons Performance and Analysis Task, a very simple concept was examined for the purpose of illustrating a point.

It has been fairly evident from the testing of different less-lethal kinetic-energy projectiles, and from the laws of physics, that the relatively slow application of force tends to move objects rather than tear them apart.

Since the severity of the injury sustained is roughly related to impacting energy for a given-size projectile, and the ability to change motion is definitely related to momentum transfer, it was decided to consider an inexpensive series of tests utilizing a long, heavy, low-velocity projectile which maintained integrity on impact. The projectile used in these tests was a sawed-off drill rod 3.25 inches long, 0.3125 inches in diameter, and weighing approximately 550 grains (0.08 pound). The round was fired by means of an air-gun system at a velocity of 400 feet per second. (The convenience of launching this projectile with the air-gun system necessitated fitting each end of the rod with a teflon plug to support the rod in a smooth barrel and seal the gas pressure under projectile acceleration (Figure 14, Configuration No. 1). It had the same impact energy (approximately 200 foot pounds) as a 158-grain, round-nose, .38-caliber projectile fired at a velocity of 750 feet per second.

TABLE 8

Average Pattern As A Function Of Range -
No. 4 Lead Shot - Ricochet Fire - All Shooters

Range Yards[a]	Average Horizontal Dispersion Inches	Average Vertical Dispersion Inches
5	7.9	4.7
10	17.6	6.9
12	22.4[b]	13.9

[a]For safety reasons, the one- and three-yard ranges were not used for the ricochet test-firings.

[b]Actual horizontal dispersion was probably greater than the target frame area.

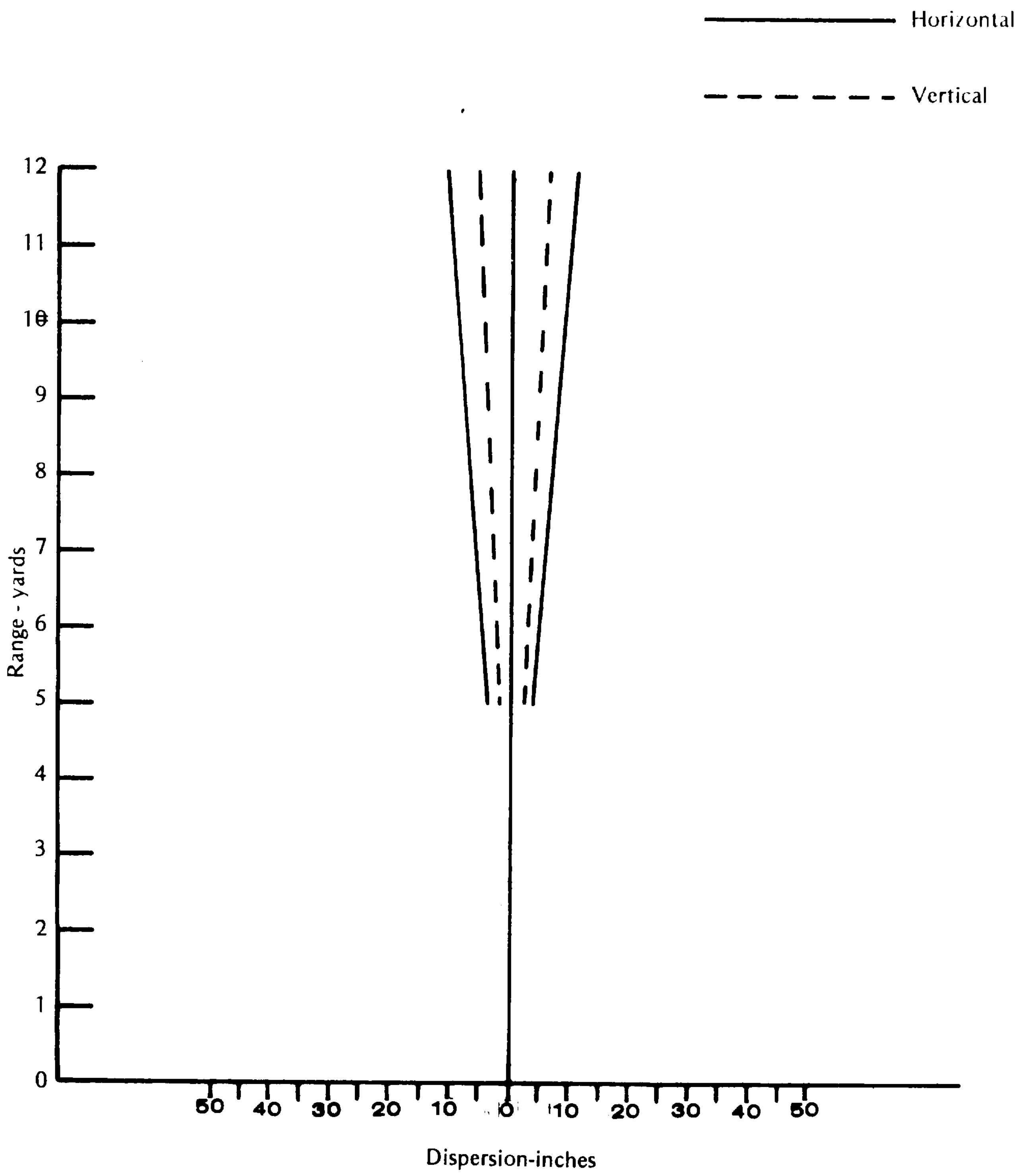


Fig. 7. No. 4 lead shot-ricochet fire—all shooters.

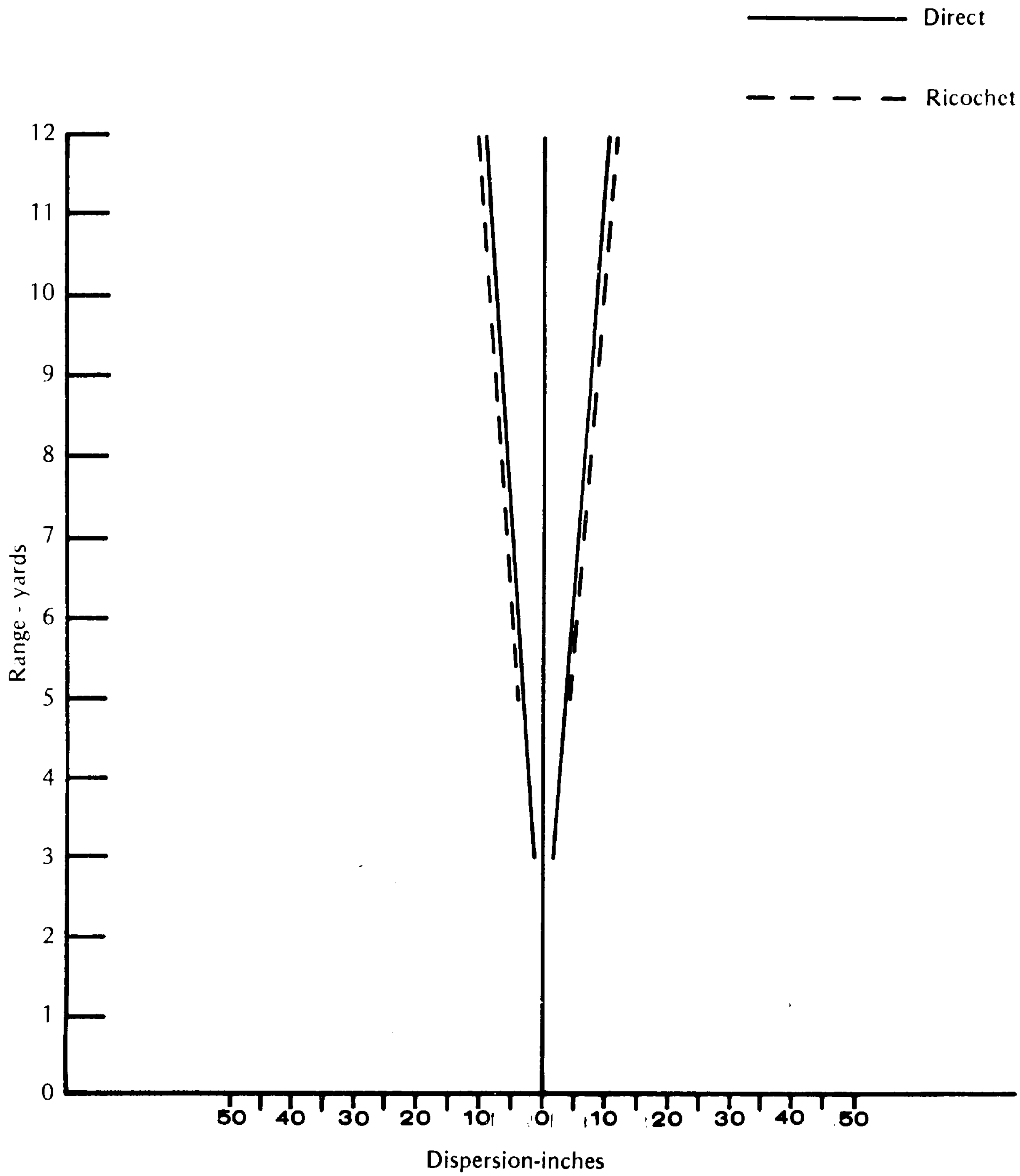


Fig. 8. Comparison of horizontal dispersion: Lead-shot—direct fire versus ricochet fire.

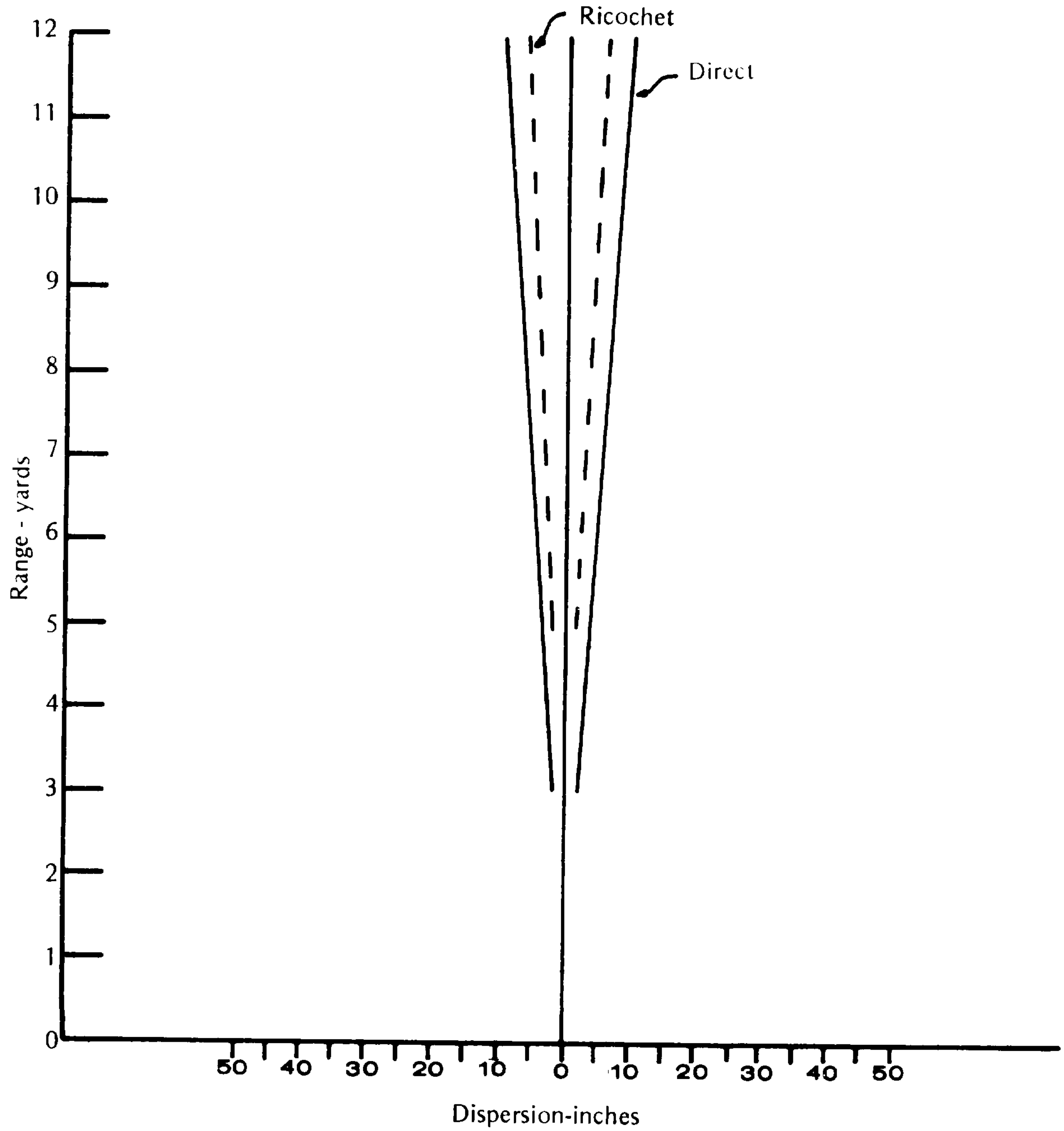


Fig. 9. Comparison of vertical dispersion: Lead shot--direct fire versus ricochet fire.

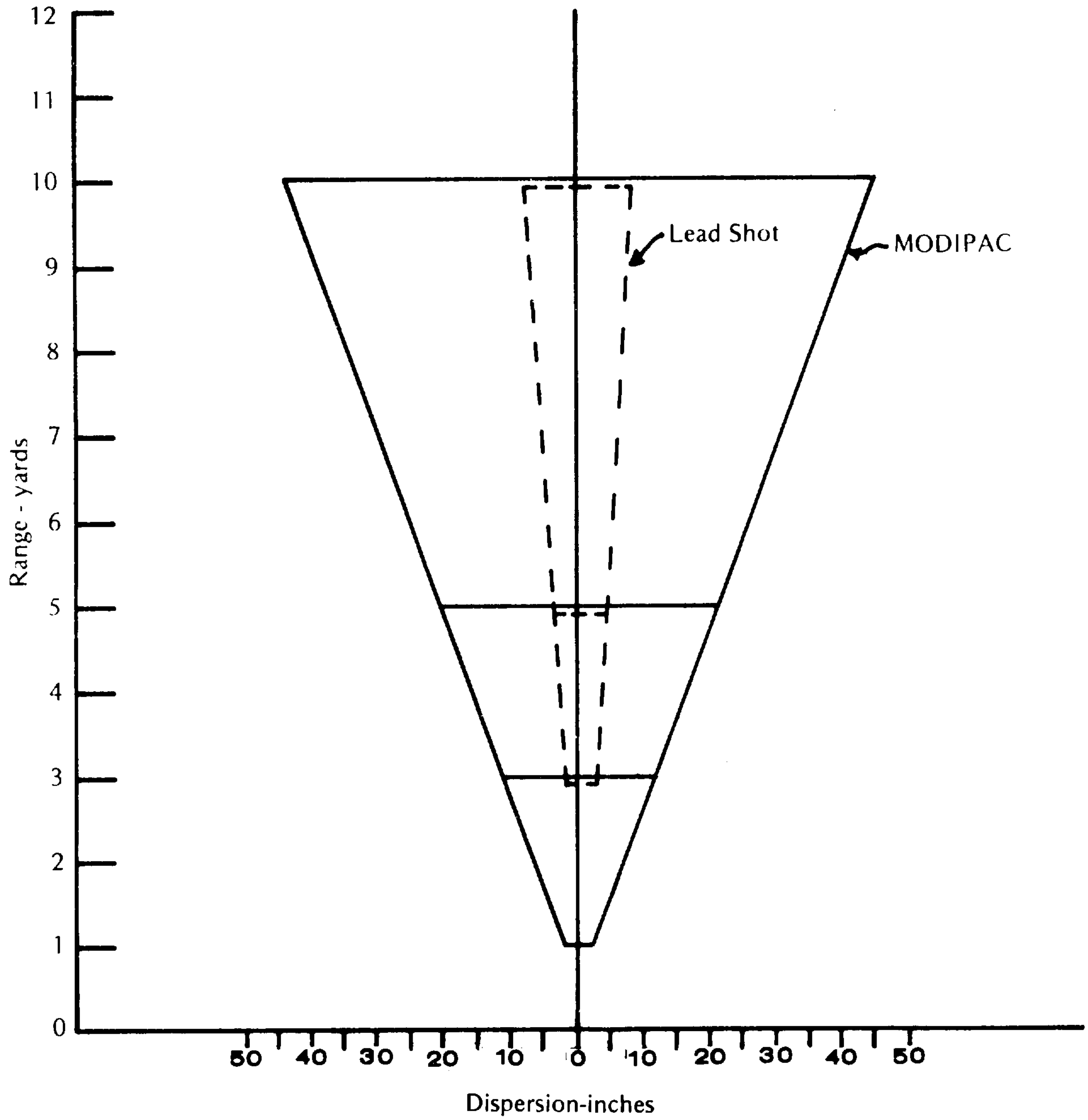


Fig. 10. Comparison of horizontal dispersion: MODIPAC versus lead-shot—direct fire mode.

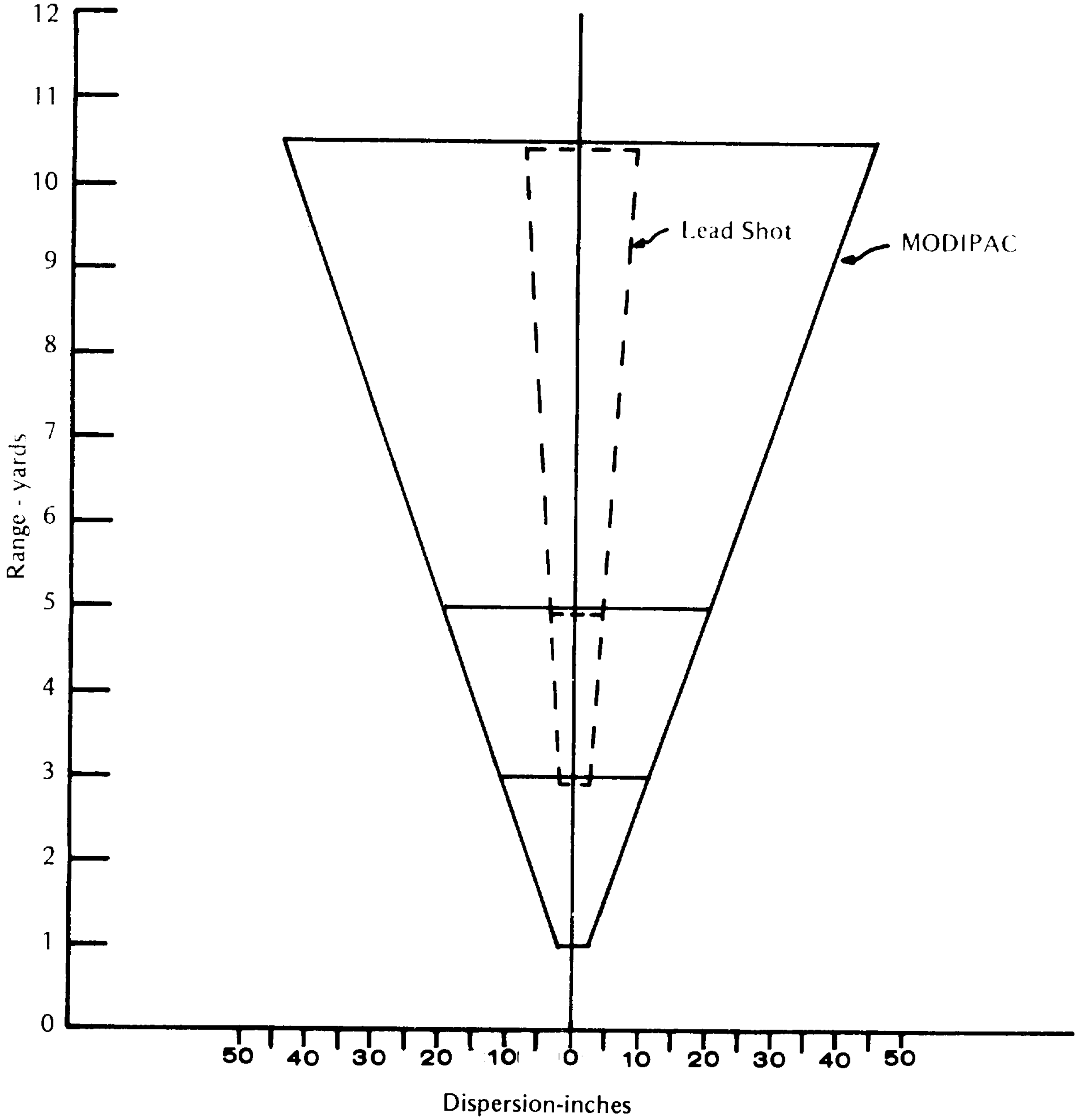


Fig. 11. Comparison of vertical dispersion: MODIPAC versus lead shot—direct fire mode.

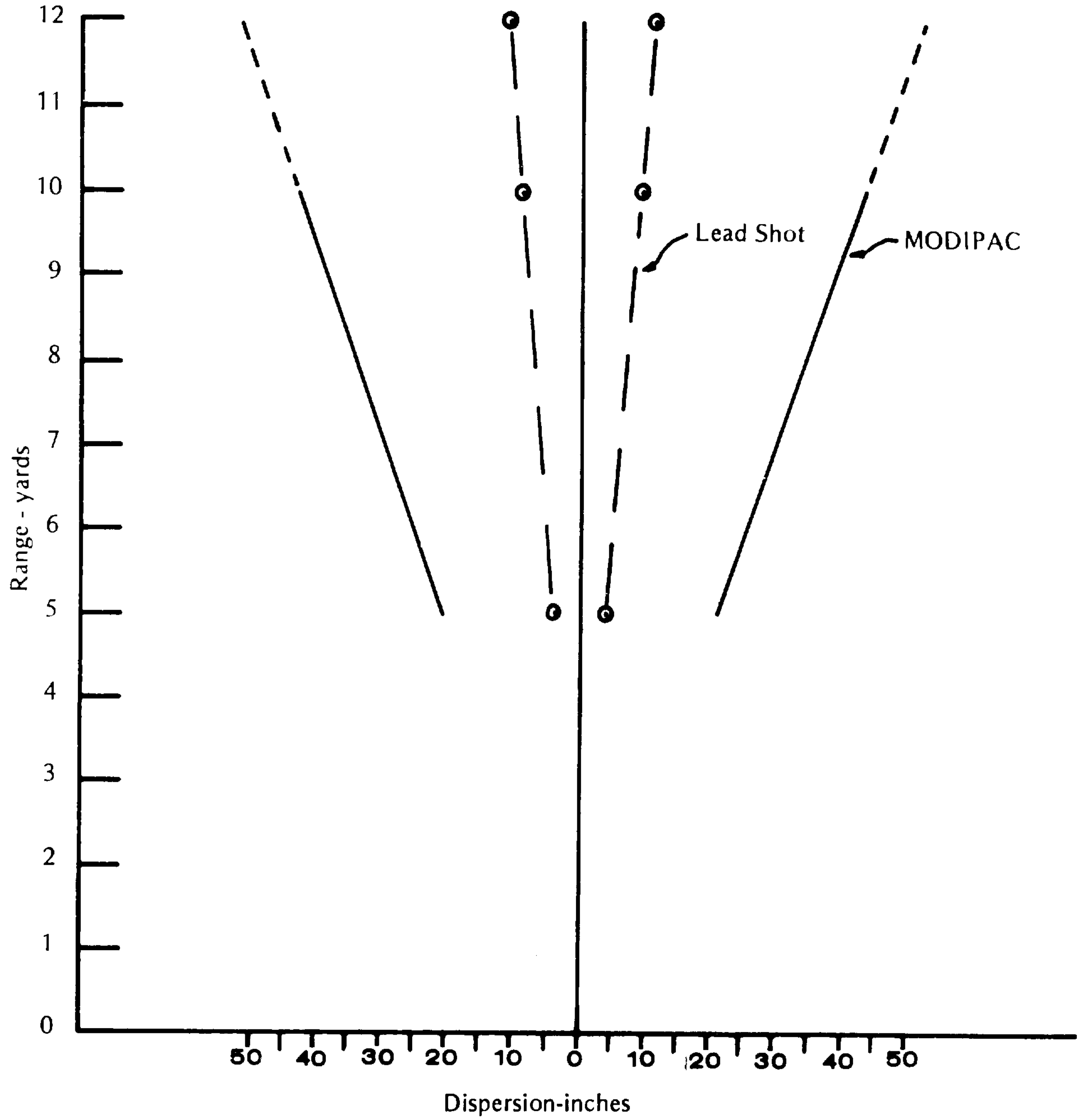


Fig. 12. Comparison of horizontal dispersions: MODIPAC versus lead shot—ricochet mode.

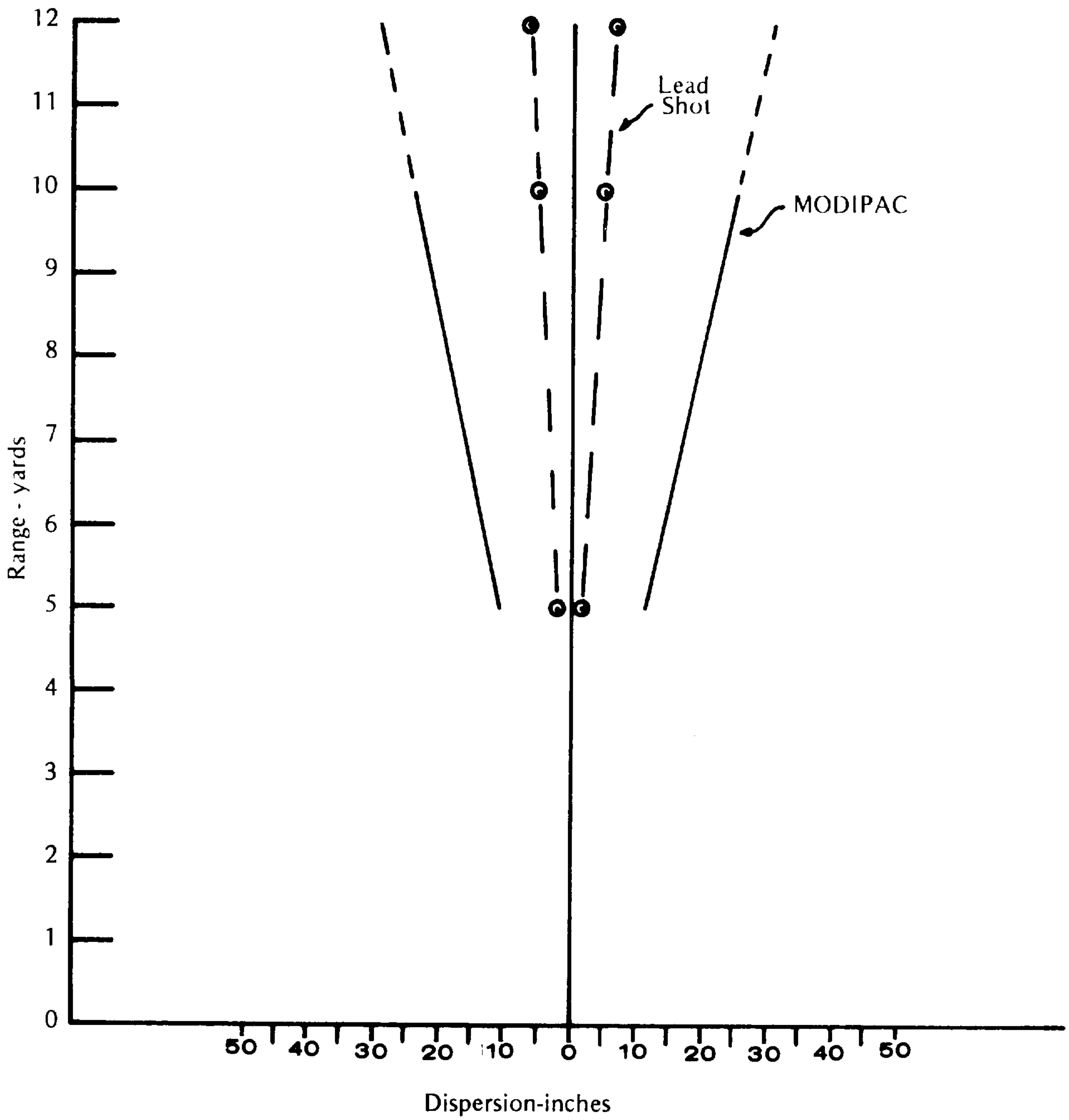


Fig. 13. Comparison of vertical dispersions: MODIPAC versus lead shot—ricochet mode.

TABLE 9

Comparison Of Overall Target Accuracy
Between The MODI-PAC And The No. 4 Lead Shot

Range Yards	MODI-PAC σ_t (mils)[a]	No. 4 Lead Shot σ_t (mils)[a]
3	2.99	4.21
5	4.20	5.09
10	15.47	3.22
12	15.40	4.37

NOTE: t = target
σ = standard deviation of miss distances

[a]At a range of three yards, one mil is 0.11 inches; at a range of 12 yards, one mil is 0.43 inches.

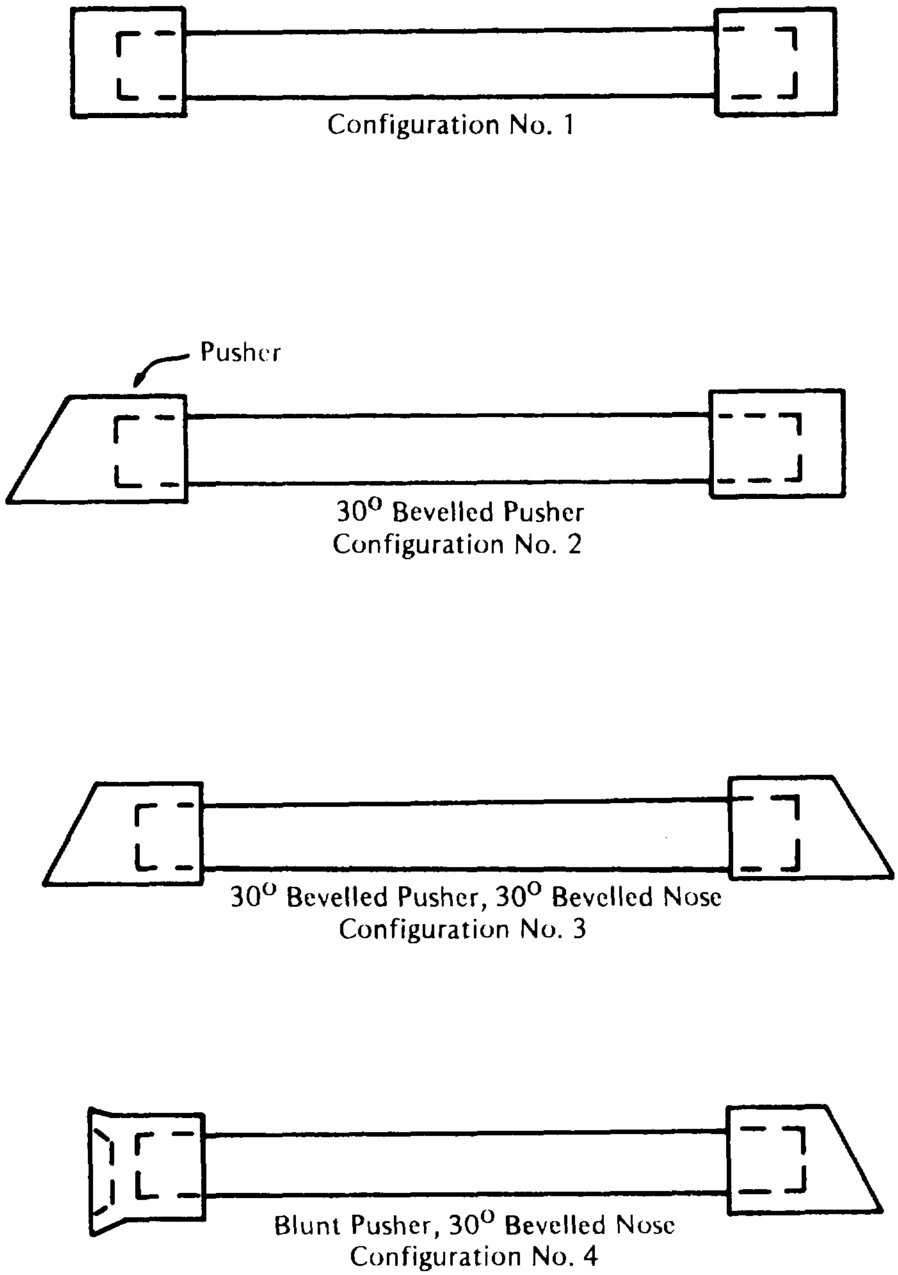


Fig. 14. Flying Baton configurations.

It was much simpler to fire the rods than to do a ballistic analysis of the projectile flight, and there was some surprise to find out that at short ranges the projectile was extremely accurate (less than one mil ballistic dispersion) and stable. Since the projectile was neither fin nor spin stabilized, it was assumed that it would tumble even at very short ranges.

Since one of the original ideas was that a tumbling long projectile would slap a target if any portion of the projectile hit the target, in subsequent firings tumbling was induced by utilizing angular (30°) plugs on either or both ends of the projectile (Figure 14, Configuration No's. 2, 3, 4). Velocity was measured using lumiline screens and velocity computing chronographs; paper yaw screens were set up at ranges of 10, 15, 20, 30 and 40 meters to grossly monitor projectile stability. The orientation (up, right, down, left; 0°, 90°, 180°, 270°, respectively, as viewed in the direction of projectile travel) of the bevelled pusher surface was changed through increments of 90° to test position effects. (One control projectile (original configuration) was fired under these test conditions for comparative measures.) The results of the final firing tests are presented in Table 10.

Even the tumbling projectile produced better accuracy than anticipated, viz., less than 1.5 mil ballistic dispersion at 10 meters range. Therefore, the concept was carried one step further by studying physiological effects under another task (Task IX which dealt with the physiological effects of impacts from various projectiles).

The Task IX study results showed that one of the things which had been anticipated did occur; namely, in three out of four thigh shots a femur was fractured–a not too common feat with the standard 158-grain, round-nose, .38-caliber projectile of equivalent engery, because of the problem of accurate impact on the bone. For two of the three fractures, a lateral displacement of the bone was effected. In a human fleeing suspect with a similar condition, the individual would immediately fall down since there is no support for the leg. (In the one shot where the bone was not fractured the impact was parallel to the bone and the bone was not hit.)

For thorax shots with a Flying Baton, the entire energy of the round is absorbed by the target. This again, is a condition not usually found with a standard .38-caliber projectile since a random impact usually produces a through-and-through wound at short ranges.

It appears that the "Flying Baton" has some very definite advantages over the standard .38-caliber projectile on a round-for-round basis. At short ranges, where most law enforcement engagements occur, the Flying Baton would give more protection to the police since all the energy of the round would, upon impact, be absorbed by the target. In the sensitive condition of a fleeing felon, where the officer's life is not threatened, the projectile could be aimed low and the chance of stopping a fleeing suspect without fatally wounding him appears high when compared with the .38-caliber projectile.

The primary trade-off in comparing the Flying Baton and the standard .38-caliber projectile is range. AT 40 meters range the ballistic error is of the order of 10 mils and the projectile is slowing up appreciably. However, this also means that the round is far less dangerous to a bystander in the background in the event that the intended target is missed.

TABLE 10

Flying Baton, Final Configuration And Stability Study

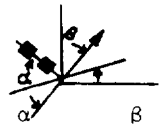
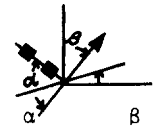
Shot No.	Pressure Regulator Setting PSI	Velocity Ft/Sec[a] S_1	S_2	Projectile Configuration No.	Bevel Orientation  Pusher	Nose	Yaw Screen Range, Meters	Impact Angles (Yaw) Degrees  α	β
1	400	418.0	410.3	2	0	N/A	10	90	-
							20	35	-
							30	0	-
							40	Missed	-
2	400	397.6	380.2	2	90	N/A	10	45	45
							20	90	30
							30	90	25
							40	90	85
3	400	392.7	381.1	2	90	N/A	10	40	0
							20	35	20
							30	45	30
							40	Missed	Missed
4	400	441.6	423.7	2	90	N/A	10	45	45
							15	60	30
							20	30	15
							30	35	90
							40	10	10
5	400	443.0	425.7	2	90	N/A	10	40	15
							15	45	40
							20	45	45
							30	20	5
							40	30	20
6	400	405.0	394.9	3	90	270	10	70	60
							15	45	50
							20	35	45
							30	30	10
							40	15	75
7	400	-	-	3	90	270	10	90	5
							15	50	45
							20	90	55
							30	55	0
							40	5	10
8	400	386.5	368.8	3	90	270	10	45	30
							15	55	30
							20	45	20
							30	35	50
							40	5	90
9	400	403.7	397.4	4	N/A	270	10	90	85
							15	50	0
							20	80	45
							30	60	75
							40	90	40
10	400	404.3	398.5	4	N/A	270	10	85	75
							15	45	0
							20	90	70
							30	80	80
							40	45	5

TABLE 10 (Continued)

Shot No.	Pressure Regulator Setting PSI	Velocity Ft/Sec[a] S_1	S_2	Projectile Configuration No.	Bevel Orientation 270° 90° Pusher	Nose	Yaw Screen Range, Meters	Impact Angles (Yaw) Degrees  α	β
11	400	407.6	402.9	4	N/A	270	10	90	60
							15	90	10
							20	25	40
							30	80	15
							40	Missed	Missed
12[b]	400	425.0	-	1	N/A	N/A	30	0	-

NOTE: S_1 = first set of velocity screens

S_2 = second set of velocity screens

[a]The distance from the gun muzzle to the first velocity screen was approximately 1.2 meters, the distance between the screens was approximately 0.3 meters and the distance between the sets of screens was approximately 0.6 meters.

[b]Control projectile.

CONCLUSIONS

1. The MODI-PAC appears promising for use in relatively short-range confrontations. A series of tests should be conducted, however, utilizing both the direct-fire and the ricochet-fire techniques to determine the physiological effects (other than skin damage) of impacts with this round. Also, scenario applications for this round should be considered in order that it may be evaluated using the less-lethal evaluation model.

2. The standard velocity 12-gauge, No. 4, lead-shot round should, likewise, be subjected to physiological testing, and scenario application utilizing both of the aforementioned firing methods. This round could prove useful for those situations involving the longer ranges. At the same time it could provide the officer with additional protection in situations where the officer's life is threatened.

3. There is at present no conventional weapon for firing the Flying Baton. However, the results of these few preliminary tests show that the concept of a long slug is promising. Additional work is needed to fully develop and evaluate the round and, in addition, to develop a reasonable weapon for firing it.